Hydrothermal Systems in Sedimentary Basins

Supervisors: Dr. Nick Schofield (Birmingham), Dr. Simon Holford (Adelaide), Dr. Paul Green (Geotrack International), Dr. Steve Jones (Birmingham), Dr. Carl Stevenson (Birmingham).

Abstract

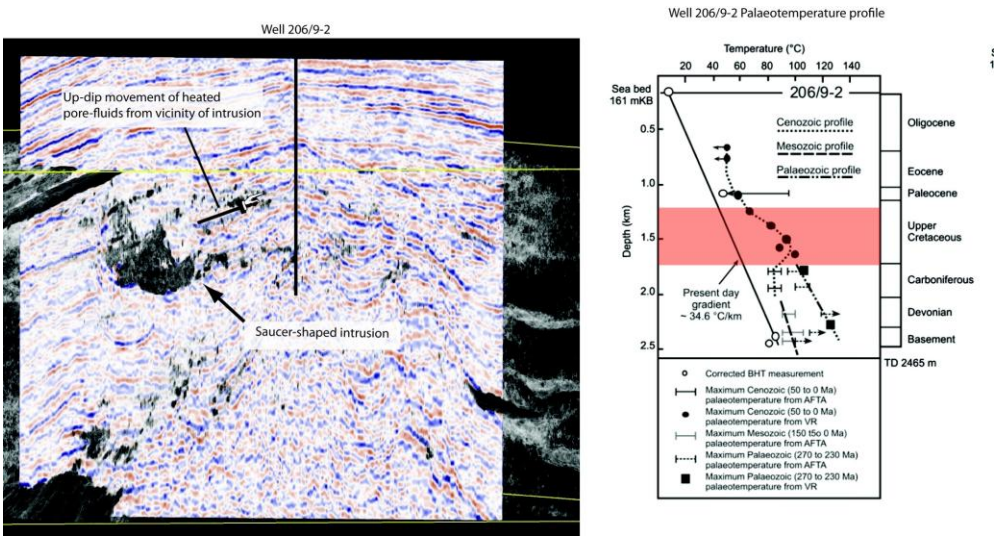
As hydrocarbon exploration moves increasingly into frontier basins containing intrusive volcanic sequences (e.g. Faroe-Shetland Basin, Greenland, Brazil, the Australian Bight) the heating effects of intrusions on both reservoir and source rocks can pose major risks to extant hydrocarbon systems.

On localised scales, the effects of direct flash heating by intrusions can lead to contact metamorphism, however a less well understood phenomenon is the creation of longer term hydrothermal fluid systems within the subsurface, which are often recorded by 'bell-shaped'/non-linear palaeotemperature-depth profiles in wells. These systems can transmit heat large distances away from the intrusions and into a basin, where hot fluids can drastically alter porosity & permeability of reservoir sequences through deposition of secondary minerals, as well as interacting with any hydrocarbons that may already be in place within a particular sequence.

Furthermore, the heating of organic rich source rocks by intrusions has been linked to major deviations in the past earth climate such as the Palaeocene-Eocene Thermal Maximum, but uncertainty remains in the ability for the contact metamorphic effects to do this alone.

Within this project, the student will work on data from two key hydrocarbon regions; the Faroe-Shetland Basin and offshore Australia. The objectives are to map the volcanic plumbing systems and integrating this with well data and palaeotemperature profiles, in addition to conducting fieldwork to understand diagenetic changes caused by intrusions. It is hoped that the work will allow for broad relationships to be established that can be applied in general terms to a sedimentary basin. It is envisaged that the student will spend periods of their study at University of Adelaide with additional possibilities for undertaking internships within the hydrocarbon industry.

The student will receive world-class training in seismic interpretation and well analysis, and future employment prospects could be academic or industrial.



Seismic and palaeotemperature data from well 206/9-2 in the Faroe-Shetland Basin: note distinctive bell-shaped palaeotemperature profile (after Mark et al., 2008) within the Upper Cretaceous sequence, which may witness hydrothermal circulation related to nearby igneous intrusions

Description of Work:

The work will fall into three main areas

1. Seismic interpretation of the volcanic sequences (both intrusive and extrusive) within a basin and reconstruction of the overall magmatic system.
2. Analysis of new and existing palaeotemperature data (e.g. VR, AFTA), to understand both contact and hydrothermal heating events. In addition fieldwork will be undertaken looking at diagentic effects on intrusions on host rocks on the Isle of Skye and Mull
3. Integration of basin geology and volcanic systems with well data to provide a detailed understanding of the regional palaeo-hydrothermal systems that have operated within the basin.

Fieldwork and sample collection (e.g. the Isle of Skye, Isle of Mull) will allow direct calibration of well data with field examples to understand diagenetic changes. The student will join a vibrant group of researchers at the University of Birmingham, where significant intellectual critical mass in the field of volcanic systems in sedimentary basins exists. The project is suitable for any individual with a 2:1 (or higher) degree with a Earth Science background. The student will receive training in seismic interpretation, well analysis, GIS and basin analysis. The PhD project will fall under the umbrella of the Volcanic Margins Research Consortium, and as a result the student will benefit from substantial exposure to the oil industry and academics from other leading institutions. Employment post-PhD could be sought either within the hydrocarbon industry or within academia.

Contact: Dr. Nick Schofield (nick.schofield@abdn.ac.uk) for more details.